

## 4G WIRELESS NETWORKS: OPPORTUNITIES AND CHALLENGES

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### ABSTRACT

Wireless technology has transformed our lives in many ways. Until very recently, we needed a computer wired to a port, to get online. Even wired telephones are becoming a thing of past. Nowadays, we use our mobile phones for banking, to check ticket availability at a Cinema Hall, and many more. Wireless communication is the transfer of information over a distance without the use of enhanced electrical conductors or "wires". And, Wireless networking refers to any kind of networking that does not involve cables. It helps in saving the cost of cables for networking in addition to providing the mobility. 4G is a short form of Fourth (4th) Generation Technology. 4G Technology is basically the extension lead in the 3G technology with more bandwidth and services offers in the 3G. The expectation for the 4G technology is basically the high quality audio/video streaming over end to end Internet Protocol. WiMAX or mobile structural design will become progressively more translucent, and therefore the acceptance of several architectures by a particular network operator always more common.<sup>[1]</sup> In this paper, we are going to discuss about different categories of 4G technologies, The difference among

1G,2G,3G and 4G and then Opportunities and challenges of 4G.

### 1. CATEGORIES OF 4G TECHNOLOGIES

Many Technologies appear in many different flavors and have many different tags attached to them, but that does not really indicate that they are moving in dissimilar tracks. The technologies that fall in the 4G categories are LTE and WiMAX. 4G Technology offers high data rates that will generate new trends for the market and prospects for established as well as for new telecommunication businesses. 4G networks, the stage of mobile communications that will enable things like IP-based voice, data, gaming services and high quality streamed multimedia on portable devices with cable modem-like transmission speeds. It's a successor to 2G and 3G wireless, whereby the first signified the shift from analog to digital transmissions, bringing data services like SMS and email to mobile phones for the first time, and the second refers to the advent of things like global roaming as well as higher data rates.

### 1.1 WiMAX

WiMAX stands for Worldwide Interoperability of Microwave Access previously worked as fixed wireless facility under the 802.16e band. Now the modified standard 802.16m has been developed with the properties of speed, wide spectrum, and increase band. Smartphone's with Wireless Access are going to be introduced in the market are the model 4G mobiles. These Smartphone are equipped with the wireless internet accessibility and no fear of losing connection while travel from one tower to another tower range.

Based on the IP wireless connectivity, it increases the optimization for the internet. It manages the voice through packet-switching instead of circuit switching. Internet connectivity with specific IP not only increases the speed but also reliability of the sending and receiving of data. During a phone call when caller send the information by connecting to WiMAX network, this information first processed to the internet home and then spread widely. Most of the time this transmission happens very fast problems arise in case of spectrum, bandwidth and data. In case spectrum is not wide, shorten bandwidth and specific data carries through the internet. Arrival of 4G has diminished all the fears of lower bandwidth, narrow spectrum and amount of data send / receive. This WiMAX

technology has a high speed of data transfer rate with additional capacity for the subscribers and ready to carry big amount of data. Previous generations were suffering because of low speed which ultimately covered in the 4G.

### 1.2 LTE (Long Term Evolution)

LTE (Long Term Evolution) is introduced by Verizon. LTE is considered to be promising high data transfer speed. LTE is supposed to provide internet facility using both systems. It has the ability of transition from one mode to another. LTE is developed on radio waves technology. This not only increases the speed but also the amount of data allowed through the same bandwidth and results into lower cost. As LTE is compatible with 3G technology so it not only increases the speed but also prevents the need of new network and can work through the same infrastructure. LTE will not only support the functions of 3G but also incorporate some newer ones. LTE is using MIMO (Multiple input multiple output) able to send and receive huge data negative in the sense that it will overload the base stations networks. While seeing the working methodologies of both technologies considered to be the standards of 4G.

## 2. Basics of 1G, 2G, 3G and 4G

G's	Types of system	year	Purpose
1G	Analog system	1970 In US	AMPS(Advance Mobile Phone System) was launched based on FDMA which allows user to make voice calls within a country
2G	GSM(Global system for Mobile communication)	1990 In Europe	It provides voice and limited data services & uses digital modulation for improved audio quality.
	Multiple Digital system		It improved transmission quality, system capacity & coverage speech transmission. It includes GSM, CDMA & PDC.
3G	Multimedia facilities	2001 In Japan	1. UMTS, IMT-2000-single family of compatible standards that can be used worldwide for all mobile applications.  2.Data rates up to 2Mbps  3.High spectrum efficiency
4G	4G-related products are still in the development phase, with additional	started in South Korea in 2006	1. It allows everyone to access the Internet anytime and everywhere.  2. The provided connection to Internet will

	products to be developed and rolled out on a periodic basis.		allow users to access all type of services including text, databases, and multimedia.
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- GSM- Global system for mobile communications
- CDMA- Code division multiple access
- PDC- Personal Digital communication

Think of wireless generations as a handful of services that get faster and more feature-rich as newer technology becomes available. The 3G networks that we use today allow us to stream video, download music and files, and surf the web at average download speeds from 600Kb/s to 1.4Mb/s. With 4G you'll be able to do the same but at much faster rates, while the extra bandwidth opens the door for newer applications.

		Real World (avg)		Theoretical (max)		Availability
		Download	Upload	Download	Upload	
2.5G	GPRS	32-48Kbps	15Kbps	114Kbps	20Kbps	Today
2.75G	EDGE	175Kbps	30Kbps	384Kbps	60Kbps	Today
3G	UMTS	226Kbps	30Kbps	384Kbps	64Kbps	Today
	W-CDMA	800Kbps	60Kbps	2Mbps	153Kbps	Today
	EV-DO Rev. A	1Mbps	500Kbps	3.1Mbps	1.8Mbps	Today
	HSPA 3.6	650Kbps	260Kbps	3.6Mbps	348Kbps	Today
Pre-4G	HSPA 7.2	1.4Mbps	700Kbps	7.2Mbps	2Mbps	Today
	WiMAX	3-6Mbps	1Mbps	100Mbps+	56Mbps	Today
	LTE	5-12Mbps	2-5Mbps	100Mbps+	50Mbps	End 2010
	HSPA+	-	-	56Mbps	22Mbps	2011
4G	HSPA 14	2Mbps	700Kbps	14Mbps	5.7Mbps	Today*
	WiMAX 2 (802.16m)	-	-	100Mbps mobile / 1Gbps fixed	60Mbps	2012
	LTE Advanced	-	-	100Mbps mobile / 1Gbps fixed	-	2012+

**Uploading & downloading capacity of 2G, 3G and 4G (Source: <http://www.techspot.com>)<sup>[2]</sup>**

After successful implementation, 4G technologies is likely to enable global computing, that will simultaneously connects to numerous high data speed networks offers faultless handoffs all over the geographical regions. Many network operators possibly utilize technologies for example; wireless mesh networks and cognitive radio network to guarantee secure connection & competently allocates equally network traffic and bandwidth.

### 2.1 1G

First-generation mobile systems used analog transmission for speech services. Semiconductor technology and microprocessors made smaller, lighter, and more sophisticated mobile systems a reality. However, these 1G cellular systems still transmitted only analogue voice information. The prominent ones among 1G system is advanced mobile phone system (AMPS), Nordic mobile telephone (NMT), and total access communication system (TACS). All of these systems offered handover and roaming capabilities but the cellular networks were unable to interoperate between countries. Although Omni directional antennas were used in the earlier AMPS implementation, it was realized that using directional antennas would yield better cell reuse. In fact, the smallest reuse factor that would fulfill

the 18db signal-to-interference ratio (SIR) using 120-degree directional antennas was found to be 7. Hence, a 7-cell reuse pattern was adopted for AMPS. Transmissions from the base stations to mobiles occur over the forward channel using frequencies between 869-894 MHz. The reverse channel is used for transmissions from mobiles to base station, using frequencies between 824-849 MHz. AMPS and TACS use the frequency modulation (FM) technique for radio transmission. Traffic is multiplexed onto an FDMA.

### 2.2 2G

Second generation (2g) telephone technology is based on GSM or in other words global system for mobile communication. 2G network allows for much greater penetration intensity. 2G technologies enabled the various mobile phone networks to provide the services such as text messages, picture messages and MMS (multimedia messages). 2G technology is more efficient. 2G technology holds sufficient security for both the sender and the receiver. All text messages are digitally encrypted. This digital encryption allows for the transfer of data in such a way that only the intended receiver can receive and read it. Second generation technologies are either time division multiple access (TDMA) or code division multiple access (CDMA). TDMA allows for the division of signal into time slots. CDMA allocates each user a special code to

communicate over a multiplex physical channel. Different TDMA technologies are GSM, PDC, iDEN, iS-136. CDMA technology is IS-95.

### 2.2.1 OPPORTUNITIES

Digital signals require consume less battery power, so it helps mobile batteries to last long. Digital coding improves the voice clarity and reduces noise in the line. Digital signals are considered environment friendly. The use of digital data service assists mobile network operators to introduce short message service over the cellular phones. Digital encryption has provided secrecy and safety to the data and voice calls. The use of 2G technology requires strong digital signals to help mobile phones work. If there is no network coverage in any specific area, digital signals would be weak.

### 2.3 3G

Third generation (3g) telephone technology is based on GSM, which enables us to transmit packet switch data efficiently at better and increased bandwidth. 3G mobile technologies proffers more advanced services to mobile users. It can help many multimedia services to function. The spectral efficiency of 3G technology is better than 2G technologies. Spectral efficiency is the measurement of rate of information transfer over any communication system. 3G is also known as IMT-2000. 3G technologies

make use of TDMA and CDMA. 3G (Third Generation Technology) technologies make use of value added services like mobile television, GPS (global positioning system) and video conferencing. The basic feature of 3G Technology (Third Generation Technology) is fast data transfer rates. 3G technology is much flexible, because it is able to support the 5 major radio technologies. These radio technologies operate under CDMA, TDMA and FDMA. CDMA holds for IMT-DS (direct spread), IMT-MC (multi carrier). TDMA accounts for IMT-TC (time code), IMT-SC (single carrier). FDMA has only one radio interface known as IMT-FC or frequency code.

There are many 3G technologies as W-CDMA, GSM EDGE, UMTS, DECT, WiMax and CDMA 2000. Enhanced data rates for GSM evolution or EDGE is termed to as a backward digital technology, because it can operate with older devices.

### 2.3.1 TYPES OF 3G TECHNOLOGIES

- EDGE is a 3G Technology. EDGE allows for faster data transfer than existing GSM. EDGE was introduced by AT&T in 2003. EDGE has increased the GSM coverage up to three times more.
- Universal Mobile Telecommunications Systems (UMTS) conforms to ITU IMT

2000 standard. It is complex network and allows for covering radio access, core network and USIM (subscriber identity module). It is a relatively expensive technology for the network operators because it requires new and separate infrastructure for its coverage. The GSM is the base of this technology.

- CDMA is also referred to as IMT-MC. This technology is close to 2G technology GSM because it is also backward compatible.
- Digital enhanced cordless telecommunications (DECT) is another 3G Technology. It runs over a frequency of 1900 MHz
- WiMax is a 3G Technology and it is referred to as worldwide interoperability for microwave access. It is a wireless technology. It transmits variety of wireless signals. It can be operated on the multi-point and point modes. It is portable technology. This technology is based on the wireless internet access and removes the need for wires and is capable enough to provide 10mbits/sec. it can connect you to hotspot.

## 2.4 4G

4G Technology is basically the extension in the 3G technology with

more bandwidth and services offers in the 3G. Fourth Generation networks, are designed to facilitate improved wireless capabilities, network speeds, and visual technologies. The expectation for the 4G technology is basically the high quality audio/video streaming over end to end Internet Protocol. It requires substantial improvements to multimedia messaging services, including video services, in order to approve a new generation. It wants a data speed transfer rate of at least 100 megabits per second while a user is physically moving at high speeds and a one gigabit per second data rate in a fixed position.

### 2.4.1 OPPORTUNITIES

#### 2.4.1.1 Cost and Affordability

In general, 4G Networks are designed in order to create an environment that supports high-speed data transmission and increased profit margins for organizations that utilize these capabilities. Developing a successful 4G Network platform is a positive step towards the creation of a wireless and broadband environment that possesses rapid transmission speeds, data integrity modules, and other related events that encourage users to take additional risks in promoting successful utilization of these 4G tools.

#### 2.4.1.2 Capabilities and Features

The possibilities associated with 4G Networks are endless, as high-speed data transmission and associated capabilities are more feasible than ever. Consideration are the appropriate security measures, the promotion of high-speed data transmission across the network, and the ways in which data quality and integrity might be preserved in order to provide the most satisfactory results. 4G provides higher bandwidth, data rate, lower authentication overhead, and ensures that the service is constantly provided to the user without any disruption.

## **2.4.2 CHALLENGES**

### **2.4.2.1 Security and Privacy**

The 4G core addresses mobility, security, and QoS through reuse of existing mechanisms. Because of the nature of the 4G network, there is an increased likelihood of security attacks, and therefore, multiple levels of security, including increased requirements for authentication, is necessary to protect data and information that is transmitted across the network. One of the main goals of G4 networks is to blanket very wide geographic area with seamless service. Obviously, smaller local area networks will run different operating systems. The heterogeneity of these wireless networks exchanging different types of data complicates the security and privacy issues. Furthermore, the encryption and decryption methods being used for 3G

networks are not appropriate for 4G networks as new devices and services are introduced for the first time in 4G networks.

### **2.4.2.2 Quality of Service**

It was important for providers to develop an effective approach to the 4G Network that will enhance quality, provide effective security measures, and to ensure that all users are provided with extensive alternatives for downloading video, music, and picture files without delays. The main challenge of 4G network is integrating non-IP-based and IP-based devices. It is known that devices that are not IP address based are generally used for services such as VoIP. On the other hand, devices that are IP address based are used for data delivery. Hence 4G networks serves both types of devices, integrating the mechanisms of providing services to both non-IP-based as well as IP-based devices was one of key challenge.

### **2.4.2.3 Complex Architecture**

#### ***Multimode End-User Terminals***

To reduce operating costs, devices that operate on 4G networks should have the capability to operate in different networks. However, accessing different mobile and wireless networks simultaneously is one of the major issues 4G networks have been addressing. One mechanism that has been proposed to handle this problem is termed “multi-



mode devices". This mechanism can be achieved through a software radio that allows the end-user device to adapt itself to various wireless interfaces of the networks.

#### ***System discovery and selection***

Due to the heterogeneity of 4G networks, wireless devices have to process signals sent from different systems, discover available services, and connect to appropriate service providers. Various service providers have their own protocols which can be incompatible with each other as well as with the user's device. This issue may complicate the process of selecting the most appropriate technology based on the time, place and service provided, and thus, may affect the Quality of service provided to the end user.

One solution to resolve this issue is called "System-initiated discoveries". This mechanism allows automatic download of software modules based on the wireless system the user is connected. Another approach to handle this problem is based overlay networks. In such case, the end-user device is connected to different networks through an overlay network. The overlay network performs all necessary tasks such as protocol translation and Quality of service negotiation.

#### **Service and Billing**

Managing user accounts and billing them has become much more complicated with 4G networks. This is mainly due to heterogeneity of 4G networks and the frequent interaction of service providers. The research community addressed this concern and proposed several frameworks to handle the customers' billing and user account information

Some of the companies trying 4G mobile communication at 100 Mbps for mobile users and up to 1 GBPS over fixed stations. They planned on publicly launching their first commercial wireless network around 2010. As far as other competitor's mobile communication companies working on 4G technology even more quickly. Sprint Nextel was planned to launch WiMAX over 4G broadband mobile networks in United States. Some of the other developed countries like United Kingdom stated a plan to sale via auction of 4G mobile frequencies couple of years back. The word "MAGIC" also refers to 4G technology which stands for Mobile multimedia, Any-where, Global mobility solutions over, integrated wireless and Customized services.

#### **3.0 CONCLUSION**

4G is all about an assimilated, global network that is based on an open system approach. The goal of the 4G network is to "replace the current proliferation of core cellular times than 3G wireless networks with a single worldwide



cellular core network standard, based on IP for control, video, packet data and VoIP” when talking about the future for wireless networking (2003). Although 4G networking proves to be an expensive business and challenging in terms of competition, it illustrates promise for the future of networking and technology. The 4G network will revolutionize means of communications, as did its previous generations, and as will future generations of cellular technology.

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